Birds

The realignment of the Bogue Inlet channel will alter the location and may alter the amount of available intertidal shoaling habitat utilized by birds for foraging, roosting, and nesting. However, the effects from the project are expected to be temporary, since replacement of the intertidal shoaling habitat will include the immediate closure of the existing channel and subsequent sand deposition as a result of the sand dike construction.

The reformation of the intertidal floats, intertidal areas near the sand dike and the new beach habitat along 23,831 feet of Emerald Isle are expected to provide foraging, nesting and roosting habitat for birds. Therefore, negative cumulative impacts are not anticipated. However if they do occur, these effects are expected to be minimal. This assessment includes the assumption that the birds have adapted to the dynamic nature of Bogue Inlet and will continue to adapt.

Shorebirds

The purpose of many shoreline stabilization projects is the prevention of overwash processes (sediment transport across a barrier island). This process forms inlets and perpetuates the formations of sand and mud flats. These sand and mud flats are used by shorebirds and in Bogue Inlet are designated as critical habitats for wintering piping plovers. Therefore, it may be assumed that there is an important connection between various inlet and shoreline stabilization activities and the formation and maintenance of vital habitat utilized by shorebirds. The USFWS has determined that inlet and shoreline stabilization does affect sand and mud flat habitats used by shorebirds for their wintering grounds. The USFWS states that the activities result in permanent habitat loss and direct disturbances to individual birds (Federal Register Part II, 2001). The proposed project is designed to minimize direct and cumulative effects to shorebirds that utilize the area.

Piping plovers usually return to the same wintering sites from year to year. Because piping plovers have high site fidelity, certain factors such as coastal development that can lead to habitat loss, may cause stress to piping plovers. Piping plovers may be forced to relocate to habitats with inadequate prey resources. Burger (1994) states that piping plovers will move to areas not utilized by humans to forage, such as dune areas, where human access is restricted, contain higher numbers of foraging piping plovers compared to surrounding ocean and bay areas that are frequented by people. However, intertidal sand flats are preferred by shorebirds. Sand flats, especially those in the middle of the inlet, are usually isolated and therefore, loss of these sand flats can cause significant stress to shorebirds. It is important to note that the intertidal sand flats of Bogue Inlet are naturally dynamic, overwash often, and have varying degrees of persistence. The diversity of habitats available in Bogue Inlet (i.e., intertidal, beach and dune) allows piping plovers to move between habitats and maximize foraging time by limiting human interaction and disturbances (Burger, 1994).

According to Evans (1979) tidal effects are the primary influence on foraging shorebird distribution. The tide affects the amount of area available for foraging and the availability of prey (Recher, 1966; Evans, 1979). During high tide, when intertidal sand and mud flats are unavailable, species of shorebirds move to upland fields or marshes (Heppleston, 1971) or man-made habitats such as fish ponds and salt ponds (Burger, 1994). Shorebirds, such as the piping plover, are adaptable and accustomed to the changing nature of intertidal habitats, and will find suitable habitat if the sand flats in Bogue Inlet change.

Cumulative impact goals should maintain disturbance frequencies below tolerance levels than enable birds to obtain fat storage needed for long-distance migrations. It is anticipated that there will be enough available roosting and foraging sites in the project area for shorebirds, and therefore stress levels are not expected to increase.

The Bogue Inlet Channel Erosion Response Project will not result in long-term habitat loss since the majority of construction activities will be in subtidal habitat and will include the installation of a sand dike for re-establishment of intertidal habitat. The inlet is being returned to the natural historic location that shorebirds once used in the mid-70s. To protect these important breeding and wintering habitats, the inlet and shoreline restoration activities will be occur during the winter months to minimize the direct effects on shorebirds. The project will not cause significant habitat loss or significant stresses that could cause a decrease in shorebird populations.

After construction, especially in the summer months when the inlet is heavily populated with active beach goers in boats and on foot, shorebirds could be negatively impacted by the additional stress created by human activity in these normally secluded areas. Ultimately, the level of disturbance must be small enough so as not to affect the maintenance of fat reserves used for long-range migration or for maintaining adequate body temperatures under cooler temperatures (Department of Interior, 2001). However, a bird management plan is currently being reviewed by the USFWS and NCWRC that includes identifying recreational habitat for boaters and beach goers, as well as providing foraging habitat for birds. The management plan will be made available upon completion.

Waterbirds

The microhabitats of Bogue Inlet provide habitat for many species of colonial waterbirds. These microhabitats are important to the conservation of waterbirds, which range from those with no significant concern to those with high management concern as designated in the North American Waterbird Conservation plan (Kushlan and Steinkamp, 2001). Although there is a high diversity of waterbirds in the area, many of the populations are at risk from threats that are mainly habitat-based and affect all aquatic birds and aquatic resources (Kushlan and Steinkamp, 2002).

Cumulative effects must not decrease the quality or quantity of key habitats (intertidal flats and sand spits) for waterbirds. The cumulative effects of this project is not expected to negatively impact waterbirds or their foraging, nesting, and roosting habitats. Many of these areas include waterbird nesting and colonizing sites, and the project will avoid loss to any colony sites.

Shellfish

Shellfish are important to the economy of North Carolina; however, shellfish fisheries, especially oysters (*Crassostrea virginicus*), have declined over the years. This decline is due to a decrease in water quality, overharvesting, habitat destruction, disease, and increased predation.

A decrease in water quality can occur from river or stormwater runoff, and paired with solar heating can cause a reduction in dissolved oxygen in waters used by shellfish (Lenihan and Peterson, 1998). Runoff can contribute to sediment loading, nutrient loading, fecal coliform contamination, and the presence of other contaminants that are funneled into areas utilized by

shellfish. Because some species of shellfish rely on SAV habitats, persistently high turbidity levels can affect shellfish populations.

Research has shown that stormwater and agricultural runoff are the primary causes of water quality contamination along North and South Carolina coasts (Mallin et al., 2000). Federal and state laws mandate water quality protection activities through government commissions and agencies. Various federal and state resource protection agencies, including the North Carolina Division of Marine Fisheries (NCDMF), evaluate proposed projects and provide comments and recommendations on potential water quality and resource impacts. North Carolina has classified the waters of Bogue Inlet as SA ORW, meaning they are outstanding resource waters suitable for commercial shellfishing and all other tidal saltwater uses (NCDWQ, 2001; NCDWQ, 2002). These waters require more protection and have stringent bacteriological standards due to the pristine conditions of the water needed to sustain healthy shellfish populations.

Shellfish are efficient bio-accumulators that may concentrate harmful organisms, such as bacteria and viruses, when they are present in the water. Fecal coliforms can cause disease in shellfish and can cause bacterial infection in the people that consume them. Chemical contaminants such as heavy metals, hydrocarbons, and pesticides can also affect shellfish. Turbidity particles can also trap nutrients and heavy metals that shellfish can accumulate in their bodies. A consistent range of pH must also be sustained since a change in pH can affect the ability of shellfish to survive and reproduce.

Shellfish can tolerate a wider range of conditions if food is available. Tidal current conditions that are too fast or too slow may affect sedimentation, food availability, removal of biodeposits, transportation of eggs and larvae, growth, recruitment, and water quality. Oysters can use less than 10% of the oxygen available in the feeding currents passing over their gills (Burrel, 1986) and therefore are able to survive in reduced current conditions.

Scallops (*Argopecten irradians concentricus*) grow best in water currents less than 1 cm/s (0.03 ft/s) and maximum growth seems to be achieved at 0.21 cm/s (0.006 ft/s) (Eversole, 1987). Higher velocities (over 12 cm/s [(0.39 ft/s]) result in cessation of growth of bay scallops (Eversole, 1987). It has been shown that the abductor muscles of scallops work more efficiently in slow currents compared to fast currents (Eversole, 1987). Hard clams (*Mercenaria mercenaria*) grow more rapidly in areas with substantial flow (7.5 cm/s [0.24 ft/s]) than in areas with reduced water circulation. Research attributes the increased growth of hard clams in higher flows to increased food availability. Although even in optimum water currents, average growth can decrease if food is not available (Eversole, 1987).

The cumulative effects issues concerning this project involve 1) water quality; 2) habitat alteration; and 3) economic importance of shellfish as a fishery. The project is not expected to decrease water quality or destroy the habitat necessary for shellfish. Water quality is not expected to be significantly influenced by this project. No chemical or biological pollutants will be introduced to the system from this project. Temporary increases in sedimentation may occur, however, not in areas where shellfish are found. If turbidity does increase, levels are expected to remain within the state requirement and will not influence shellfish or the habitats (SAV, oyster rock, etc.) they are utilizing. Dissolved oxygen levels and pH are not expected to be affected by this project.

It has also been shown that mortalities from disease and parasites (e.g. *Perkinsus marinus*) have been attributed to an increase in environmental stresses. Environmental stress lowers shellfish's abilities to resist disease and parasites and can cause death. The project is not expected to increase environmental stress for the shellfish and any effects to shellfish will be temporary and minimal.

Benthic Community

Impacts to macroinvertebrates and infaunal species and their habitat can have a detrimental affect on the food web. Predators that forage on infauna and macroinvertebrate species include shorebirds and waterbirds, as well as fish species that migrate through the inlet and reside in the nearshore zone.

As previously discussed, sustainability of benthic macroinvertebrates and infaunal species complex habitat can be significantly affected by sediment deposition (Waters, 1995). Suffocation or loss of food sources and habitat can result in the reduction or elimination of benthic communities. A lack of adequate tidal flushing and water flow can contribute to poor water quality conditions for benthic communities, possibly leading to cumulative effects.

The project is not expected to have a negative cumulative effect on the benthic community since the project will not alter the tidal volume of Bogue Inlet. However, impacts from the dredging and placement of material will involved a temporary direct loss of infauna due to relocation and burial of the organisms. Impacts to species abundance and diversity are expected to minimal.

Nesting Sea Turtles

As previously stated in Section 4.2.4, several important nest cavity factors affecting embryonic development include water content, gas exchange and the temperature of the surrounding sand (Ackerman, 1997). The environment of the nest is influenced by the type, size and sorting of the sand (Crain et al., 1995). Incubation temperature in nests affects the sex ratios of sea turtles and temperature-dependent sex determination occurs around the middle third of incubation (Mrosovsky, 1994). Warmer temperatures tend to produce more females while cooler temperatures produce more males. The pivotal temperature, which marks the transition from males to females, occurs between 28°C and 30°C (82.4°F to 86°F) for sea turtles (Ackerman, 1997). Nest temperatures can be altered by a change in the color of the sand with lighter sand providing cooler incubating temperatures than darker sand. Nourishment projects in the State of Florida that used light colored aragonite sand, mined in the Bahamas, documented incubation temperatures 2ºC (35.6°F) cooler than the natural silicate/calcite sand (Crain et al., 1995). A change in nest temperature may lead to longer incubation times and alter sex ratios of the hatchlings.

Nourished beaches tend to contain more water (Ackerman et al., 1991) than natural beaches. An increase in the amount of water storage may result in an increase in heat retention, which may result in temperature changes within the nest (Ackerman et al., 1991). Thus, the water content of the sand can affect the temperature and atypical sex ratios may result if the nourished beach sand differs significantly from the natural beach in its thermal properties.

The beaches of Bogue Banks and Hammocks Beach State Park are the nesting ground for two species of sea turtles: the loggerhead (*Caretta caretta*) and green sea turtle (*Chelonia mydas*). Since the project is planned to occur between November and March, dredging and nourishment activity should not directly affect nesting female turtles or the emergence and migration offshore of hatchlings. The project site receives sediment from the adjacent barrier islands and is compatible with the existing sea turtle habitat. The medium-grained, well sorted material dredged from Bogue Inlet to be used for nourishing the west end of Emerald Isle is similar in characteristics to the native beaches and is expected to have little effect on the success of sea turtle nesting activities.

Seabeach Amaranth

Nash (2002) found an increase in seabeach plants in both Brunswick County and Bogue Banks, post beach nourishment activities. Nash supported the idea of habitat recovery for seabeach, stating that "prior to the renourishment projects, there was little area of beach where high tides did not reach the toe of the frontal dune so there was no dry sand habitat". He believes that there is a "good seed bank in beach habitat for this plant, but not storm events and lack of habitat prevent establishment". Nash (2002) found the seabeach to be a "prolific seed producer", capable of producing thousands of seeds during one growing season.

Randall (2002) found that the cyclical effects of hurricanes on seabeach amaranth to be positive by providing suitable habitat (blown-out dunes and overwash areas) for the plant. He found that hurricanes can uncover dormant seeds buried beneath the sand, which can then proliferate and escape predation in a strained environment.

The combination of available habitat and use of native sand material placed on adjacent the adjacent beach is expected to have a positive cumulative effect on the seabeach amaranth population. It is anticipated that the sand from the inlet channel may contain seeds in their dormant stage that will grow once deposited on the beach. The placed sand is expected to be reworked through aeolian processes, depositing the seeds in the dry beach, frontal dune habitat.

Submerged Aquatic Vegetation

All SAV habitats are found in shallower areas, usually less than two meters, where sufficient light for photosynthesis can penetrate through the water. Light, salinity, substrate, temperature, water currents and wave action all influence the spatial and temporal distribution of submerged aquatic vegetation, with salinity as the primary factor. In recent years, eelgrass beds have been declining all along the Atlantic coastline due to agricultural practices. Excessive nutrient loading can lead to and increase algal blooms resulting in a reduction in water clarity, the ultimate dying off of seagrass beds and the increase in sediment loads. Cumulative impacts are most typically caused by excessive nutrient loading from non-point source pollution.

It is anticipated that negative indirect effects may occur as a result of temporary increased sediment loading during and immediately post-construction. The degree to which these effects will occur is unknown. Aerial photography and ground-truth monitoring collected before and after construction will determine the effects of sediment loading on SAV in the project area.

Salt Marsh Ecosystems

In general, estuarine habitat is being lost or degraded in direct proportion to human population density in coastal areas. Much of the decline of salt marsh has been through alteration to the flow of water to these habitats, such as dams, levees, dikes, dredge and fill operations, drainage, and roadways (NOAA, 2001).

This project is not expected to have a negative cumulative effect on the salt marsh ecosystem since the project will not alter tidal volumes and/or restrict flow to the salt marsh system. Changes in elevation, salinity levels, sediment load and shoreline erosion are expected to be minimal due to an alteration of the flow patterns.

Water Quality

As previously stated, water quality in an estuarine system is most effected by a change in salinity levels. During the year, Bogue Inlet has different periods of high, transitional, and low salinity levels. The realignment of Bogue Inlet is not expected to affect salinity since the project will not alter the volume of water flowing in or out of Bogue Inlet. However, the change in flow patterns due to a relocation of the channel may initially have a minimal effect on the adjacent estuarine system. If changes in salinity occur, the natural variability of the inlet suggests that the flora and fauna are adaptable and capable of surviving a variable salinity regime.

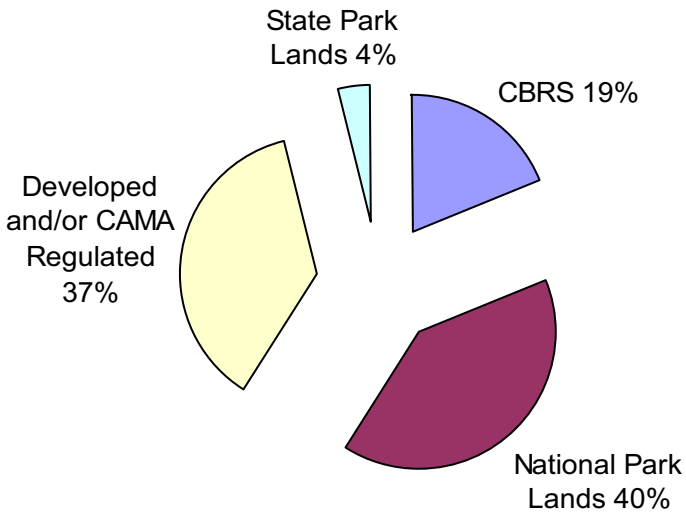
The following is a description of how similar project activities within proximity to the Bogue Inlet Project Area may affect a resource.

12.1 Beach Nourishment

Beach nourishment activities typically include the construction and long term (50 year) maintenance of a beach and dune system. The degree of cumulative impact increases proportionally with the total length of beach nourishment area constructed. Existing beach nourishment activities occur, on average, along three miles of beach per year (USACE projects only) or along one percent of North Carolina beaches. The minimum of activities that have occurred in any given year is zero. The current maximum affected beach incorporates 13 miles or about 4 percent of North Carolina ocean beaches. Proposed beach nourishment activities average 17 miles or up to 5 percent of all North Carolina ocean beaches per year. In any given year, a minimum of zero to a maximum of 42 miles (13 percent) of North Carolina ocean beaches could be nourished.

The first federal North Carolina beach nourishment projects were constructed at Carolina and Wrightsville Beaches in 1965, and totaled about 6.4 miles. Most of the remaining developed North Carolina coast is currently under study by the USACE - Wilmington District for potential future beach nourishment projects. Refer to Figure 12.1. Previous studies (Dare County EIS, dated September 2000) included speculation that approximately 88 miles or about 28 percent of the North Carolina coast could have private or Federal beach nourishment projects by 2015.

Figure 12.1 North Carolina- CAMA, PArk Land, or CBRS Protected Beaches



Beach quality sand is a valuable resource that is highly sought after by beach communities to provide wide beaches for both recreation and tourism, and to provide hurricane and wave protection for public and private property in these communities. When beach quality sand is dredged as a result of navigation projects, it has become common practice for the USACE to make this resource available to beach communities, to the maximum extent practicable. However use of the sand material on the adjacent beach must ensure that the material represents the native beach material by size and color and also identifies a low silt and shell hash content. Meeting each of these parameters is crucial especially for the sea turtle nesting populations that utilize the nourished habitat.

The Bogue Inlet project will involve the use of well-sorted inlet material to nourish approximately 23,831 feet along the west end of Emerald Isle. The use of this highly compatible material will assist in re-establishing the natural beach community for the resources that utilize this habitat. Therefore, this beach nourishment project is expected to have minimal cumulative effects.

12.2 Inlet Relocation

Existing inlet relocation activities include 3 out of 21 (Tubbs, Mason, and Bogue Inlets) or about 10 percent of all inlet complexes south of Cape Lookout, North Carolina have been relocated. Proposed inlet/channel relocation projects projected to occur in the near future include Bogue Inlet (1 out of 21 or ~5 percent). Relocation projects, such as Mason and Bogue Inlets can provide beach habitat for birds, nesting sea turtles, and seabeach amaranth, which may provide cumulatively positive effects.

Maintenance activities for these inlet relocation projects typically occur every one to three years, however the maintenance schedule is highly dependent on storm events, littoral drift, tidal prism/channel cross-section, and rainfall events. Maintenance dredging for Mason Inlet is expected to occur in the year 2005; 2006 for Bogue Inlet; and sometime in the near future for Tubbs Inlet.

Similar to maintenance dredging, inlet relocation efforts usually occur within the inlet complex and occur over a relatively short timeframe. The relocation of Bogue Inlet Channel is proposed to occur in the near future in 1 inlet out of 21 inlets (5%) located south of Cape Lookout. Therefore, the potential cumulative effects from the relocation efforts may be considered insignificant and minimal.

TABLE 12.1

BOGUE INLET
PROJECTS FROM PAST 50 YEARS
PAST, PRESENT, RFFA

PROJECTS	PAST	PRESENT	RFFA[3]	MAGNITUDE	SIGNIFICANCE
Inlet Projects					
Inlet Openings					
Drum Inlet Opening & Dredging	X			1+/6-	High
Carolina Beach Inlet Opening	X			4+/4-	High
Inlet Closures					
Moore Inlet Closure	X			3+/1-	Low
Inlet Navigation Projects					
Oregon Inlet Dredging & Disposal	X	X	X	3+/0-	Low
Hatteras Inlet Dredging	X	X		0+/0-	Minimal
Beaufort Inlet Dredging	X	X	X	0+/1-	Very Low
Bogue Inlet Dredging	X	X	X	0+/3-	Low
New River Inlet Dredging	X	X	X	1+/3-	High
New Topsail Inlet Dredging	X	X	X	0+/1-	Very Low
Rich Inlet Dredging	X	X	X	3+/1-	Low
Carolina Beach Inlet Dredging	X	X	X	0+/0-	Minimal
Tubbs Inlet Dredging			X	3+/0-	Low
Shallotte Inlet Dredging	X	X	X	3+/0-	Low
Lockwood's Folly Inlet Dredging			X	0+/0-	Minimal
Inlet Relocations					
Bogue Inlet Relocation		X	X	3+/0-	Low
Mason Inlet Relocation		X	X	6+/1-	High
Tubbs Inlet Relocation	X			0+/0-	Minimal
Beach Nourishment Projects					
Carteret Co. Bogue Banks Beach Restoration Project		X	X	3+/0-	Low
Dare County Beaches North Beach Nourishment			X	3+/0-	Low
Bogue Banks Beach Nourishment		X	X	3+/0-	Low
Camp Lejune Beach Nourishment			X	3+/0-	Low
Topsail Island Beach Nourishment			X	3+/0-	Low
Topsail Beach/West Onslow Beach Nourishment & Terminal Groin			X	3+/0-	Low
Figure 8 Island Beach Nourishment	X	X	X	3+/0-	Low
Wrightsville Beach Beach Nourishment	X	X	X	3+/0-	Low
Carolina Beach Beach Nourishment	X	X	X	3+/0-	Low
Kure Beach Beach Nourishment	X	X	X	3+/0-	Low
Fort Fisher Revetment	X	X		3+/0-	Low
Bald Head Island Beach Nourishment	X			3+/0-	Low
Oak Island Beach Nourishment			X	3+/0-	Low
Holden Beach Beach Nourishment		X	X	3+/0-	Low
Ocean Isle Beach Nourishment		X	X	3+/0-	Low
Maintenance Dredging					
Nags Head/Kitty Hawk Dredge Disposal		X		3+/0-	Low
Beaufort Inlet Nearshore & Offshore Disposal Sites	X	X	X	0+/0-	Minimal
Emerald Isle Dredge Disposal	X	X	X	3+/0-	Low
Onslow Bay Dredge Disposal Islands	X	X	X	1+/0-	Very Low
Cape Fear River (Wilmington Harbor) Dredging	X	X	X	3+/3-	High
Soft Structure Projects					
Bogue Inlet Sandbags	X	X		1+/0-	Minimal
Topsail Island Sandbags	X	X	X	0+/0-	Minimal
Figure 8 Island Sandbags	X	X	X	0+/0-	Minimal
Mason Inlet Sandbag Revetment	X	X		0+/0-	Minimal
Holden Beach Sandbags	X	X		0+/0-	Minimal
Ocean Isle Sanbags	X	X		0+/0-	Minimal
Dredge Disposal Projects					
Atlantic Beach Dredge Disposal	X	X	X	1+/0-	Very Low
Pine Knoll Shores Dredge Disposal	X	X	X	1+/0-	Very Low
Hard Structure Projects					
Oregon Inlet Jetties			X	0+/3-	Low
Oregon Inlet Terminal Groin	X	X		3+/0-	Low
Cape Lookout Jetty				3+/0-	Low
Shackleford Banks Jetty				2+/0-	Low
Fort Macon Jetty & Groins	X	X		3+/0-	Low
Masonboro Inlet Jetties & Dredging	X	X		3+/1-	Low
Other Actions					
Bogue Banks Beach Scraping	X	X		2+/0-	Low
NC 12 Dune Maintenance - Hatteras Island	X	X	X	0+/0-	Minimal

NOTES:

(1) The numbers assigned to the magnitude column correspond with **Table 7.2** and the positive and negative cumulative effects designated to each project and the listed resource.

(2) A very low to very high designation was assigned to each project in the significance column **based on the number of positive and negative cumulative effects combined** (Minimal = 0, Very Low = 1, Low = 2-4, High = 5-7, Very High 8-9) listed in the magnitude column.

(3) RFFA = Reasonably Foreseeable Future: Projects that have been formally proposed, environmental documents have been prepared or are being prepared, or the relevant authorization and/or permits have been obtained but construction has not started

13.0 CEA STEP 10 – MODIFY OR ADD ALTERNATIVES TO AVOID, MINIMIZE OR MITIGATE SIGNIFICANT CUMULATIVE EFFECTS

Significant cumulative effects are not expected to occur from the proposed Bogue Inlet Channel Erosion Response Project. Several monitoring and potential mitigation measures may be implemented to minimize and avoid adverse impacts to both Federal and State protected species and their habitat during and after project construction. The following measures are anticipated benefits from the project:

1. Establishing access restrictions around piping plover nesting areas along the west end of Emerald Isle during breeding season;
2. Implementation of a habitat management plan that limits public access and usage to nesting piping plover habitat especially during nesting season;
3. Creation a sand dike along the existing main ebb channel to assist in the closure and infilling of the abandoned waterway. This measure will immediately replace a portion of the habitat lost during channel relocation and quicken the reestablishment of sufficient intertidal habitat for infaunal recruitment and beach and dune communities for turtles and bird species;
4. Installation of the sand dike will assist in the rapid growth and development of a sand spit along the western shoulder of Bogue Banks and shoaling along the ocean side of the existing channel, providing habitat for listed species and their critical habitats;
5. Sand placement and dredge operations outside of primary invertebrate production and recruitment periods (spring and fall) thereby limiting impacts to amphipods, polychaetes, crabs and clams. Natural recruitment and repopulation of disturbed areas are expected to result in minimal impacts from the sand relocation efforts;
6. Use of a qualified biologist during construction activities to monitor the construction zone for piping plover, shorebirds, colonial waterbirds, and marine mammals to avoid or minimize disruption;
7. An ocean certified cutter suction hydraulic dredge will be used to minimize the potential for impacts to sea turtles and marine mammals resulting from mobile construction equipment;
8. Biological monitoring of infaunal species, birds and salt marsh will be conducted for one-year prior to construction and for three years after construction completion. This extensive monitoring plan will be used to evaluate project affects and develop mitigation requirements if necessary;
9. Digital aerial photography, surveying and habitat ground-truthing conducted during the summer of 2003 will provide updated habitat and physical information on the project study area.
10. The higher quality material from the inlet planned for use along Phase 3 is expected to minimize impacts to sea turtles.
11. Sand compaction may be monitored within the Bogue Banks Phase 3 project area. If required, the Phase 3 project area will be tilled prior to April 1st for up to three years following project construction to address compaction issues; and
12. Visual surveys of escarpments along the project area will be made immediately after completion of project construction and remedial measures will be implemented to eliminate or minimize escarpments.

14.0 CEA STEP 11 - MONITORING OF CUMULATIVE EFFECTS

Step 11 of the CEA lists the following components that should be considered as part of a monitoring program: (1) measurable indicators of the magnitude and direction of ecological and social change, (2) appropriate timeframe, (3) appropriate spatial scale, (4) means of assessing causality, (5) means of measuring mitigation efficacy, and (6) provisions for adaptive management.

Although direct effects on EFH and bird resources have been identified, it is expected to become minimal over a short period of time. To ensure that those effects are not significant, biological monitoring plans were designed for the project to provide information regarding the utilization and habitat significance for listed, protected, and managed fish and wildlife species within the proposed project area. Due to concerns over indirect effects to Huggins and Dudley Islands, West End Beach, Bear Island, Island Number 2, areas of Bogue Sound, Hawkins Island, Jones Island, and Cedar Point Marshes in the White Oak River; these areas were considered for inclusion. Approximately 14 square miles (project area) of land and water resources in and around Bogue Inlet are being extensively surveyed through the use of aerial photography, topographic/bathymetric surveying and habitat mapping to provide accurate pre-construction baseline data. The town of Emerald Isle is coordinating with appropriate regulatory agencies in order to mitigate for any impacts identified during pre- and post-construction monitoring.

Three biological monitoring plans were developed for the project and designed to provide current baseline data upon which potential effects to sensitive resources within the project area can be evaluated. Pre-construction biological monitoring of the project area began in April 2003 and will continue until April 2004. A minimum of three-years post-construction monitoring is expected to be required by State and Federal resource protection agencies to evaluate project effects. Monitoring and sampling efforts within the study area include benthic macroinfauna sampling; piping plover, other shorebirds, and colonial waterbird monitoring; sea turtle nesting and hatching; and salt marsh community and sedimentation monitoring. Water quality sampling of turbidity will be conducted during construction to ensure that the project is in compliance with the requirements of the North Carolina Department of Environmental Water Quality.

The biological monitoring plans were submitted to the USACE on November 21, 2002 and distributed to members of the Project Delivery Team (PDT). The monitoring protocols, methods and schedules were reviewed and have been modified to address concerns presented by the USACE, North Carolina Wildlife Resource Commission, North Carolina Division of Water Quality, USFWS, NMFS, and other members of the PDT.

A summary of the biological monitoring plans are provided below.

14.1 Bird Monitoring

Bird monitoring for the project is being conducted along four transect areas: Transect Area No. 1 west end of Bogue Banks; Transect No. 2 encompasses Island No. 2 and a portion of the eastern perimeter of the mid-inlet shoal; Transect Area No. 3 encompasses the south side of Dudley Island; and Transect No. 4 extends along the eastern side of Bear Island. Bird monitoring observations are conducted by an ornithologist equipped with a spotting scope to assist in identifying nesting, roosting, and foraging activities, as well as territory establishment, courtship,

and copulating birds. Monitoring of bird species began on April 2, 2003 and will continue for one-year during the breeding, migratory and wintering periods to obtain baseline information.

Section 4 of the Environmental Impact Statement (EIS) describes in detail the bird monitoring locations assigned to the Bogue Inlet Channel Relocation Project.

14.2 Macroinvertebrate and Infaunal Sampling

An indepth description of the details of macroinvertebrate and infaunal sampling is provided in Section 4 of the EIS identifies the benthic monitoring stations for Bogue Inlet. Infaunal data for the ten sampling stations will be reported as the number of individuals from each taxon, the number of species and the total number of organisms per square meter.

14.3 Salt Marsh Monitoring

Monitoring of salt marsh habitats in the project area was designed to assess and document the potential effects of project implementation, such as sedimentation accumulation, on adjacent salt marshes. Salt marsh monitoring transects are located at the following stations: 1) north of Bogue Inlet on the east side of the main channel, 2) on the east side of Dudley Island) north of Bear Island , and 4) South Side of Dudley Island (Appendix A – Salt Marsh Monitoring Stations). A total of seven monitoring events will be conducted to determine if impacts are directly or indirectly attributed to project activities. A more detailed assessment of salt marsh monitoring is described in Section 4 of the EIS

15.0 SUMMARY

Current conditions in Bogue Inlet include: erosion of the southern shore of Dudley Island; erosion along the western end of Bogue Banks; expansion of the spit on Bogue Banks; accretion of the Emerald Isle ocean shoreline; erosion and westerly migration of Island No. 2; accretion of Island No. 1; erosion of the Bear Island ocean shoreline; and an accelerated easterly migration of the inlet channel. It is evident that most of the Bogue Inlet habitat is eroding which leads to the current extensive shoal system and swash platform present in the inlet. The inlet is very dynamic as evidenced by the historic shoreline conducted over the last several decades by Dr. Bill Cleary.

Any effects within Bogue Inlet that are associated with this project are not anticipated to have any cumulative effect on the identified resources within the spatial and temporary analysis described in this document. Effects will be limited to the permit area and they are expected to be minimal for the following reasons: dredge material compatible with beach fill material; no change in tidal flow volume (tidal exchange and salinity levels will remain unchanged); modeling shows limited distribution of sediment in the inlet complex due to channel relocation; and tidal patterns will mimic mid 1970's channel location thereby restoring the channel to historic conditions.

Listed below are the major events and associated changes expected to occur within the project area from the westward repositioning of the ebb channel:

1. Migration of the middle ground shoal (located west of the existing channel) to form the ebb tidal delta of the new channel;

2. Accretion along the ocean shoreline of Bear Island;

3. West end of Bogue Banks;
   onshore movement of ebb tidal delta at the west end of Bogue Banks
   transport and deposition of sediment along the inlet shoreline of Bogue Banks
   development of sand spit from the west end towards Bogue Inlet
   infilling of abandoned (existing) channel west of The Pointe shoreline

4. Continued migration of Island No. 2 with or without project implementation and sand dike installation;

5. Easterly transport effects along Emerald Isle that will limit overall net sediment transport along the ocean shoreline of Emerald Isle;

6. Beach nourishment of 20,000 feet (3.8 miles) of Phase 3 of the Bogue Banks project area;

7. 39,000 cy of sediment deposition transport in the southern portion of the Western Channel; and

8. 158,000 cy of sediment deposition in the southern portion of the eastern channel area of Bogue Inlet.

9. Erosion of Emerald Isle Shoreline

Effects from the proposed channel relocation and associated activities (including beach nourishment and sand dike construction) are expected to equilibrate within three years after construction. Based on recommendations of the U.S. Fish and Wildlife Service, National Marine Fisheries Service and other members of the Project Delivery Team, the proposed monitoring efforts for the project were extended for three years post-construction to assess the positive and negative direct and indirect effects from the project.

The hydrodynamic modeling conducted for the project shows direct and indirect effects from the project due to suspended sediments displaced in the water column along the East and West Channels and the south side of Dudley Island. Additional effects from the project will include the closure of the existing channel as the sand spit on the west end of Bogue Banks collapses and migrates into the abandoned channel. The effect of the sand spit migration from the placement of the sand dike may be considered to be positive since it will immediately replace lost intertidal habitat.

Due to the migratory nature of Bogue Inlet, other direct or indirect effects associated with the actions of the project may be difficult to ascertain. However, digital aerial imagery collected in during pre-construction construction condition will be compared to post-construction aerial photography collected one and a half years after project construction to determine if additional project specific effects have occurred.

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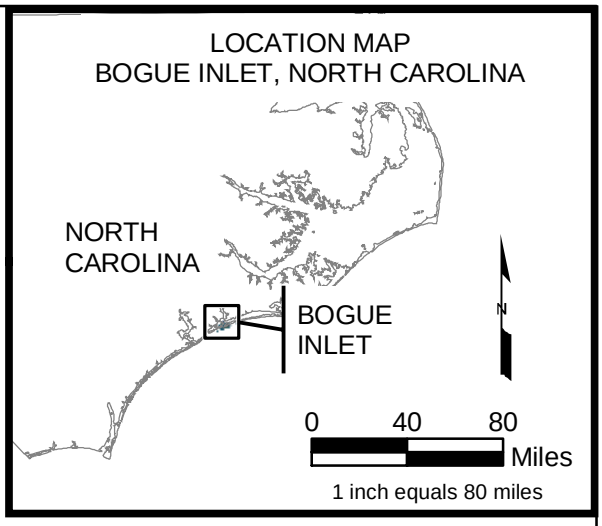
APPENDIX A

PROJECT AREA MAPS



LEGEND

PERMIT AREA

NOTES:

IMAGE: FLOWN 6/30/2003 BY EMERGE

IMAGES RECTIFIED BY
APPLIED GEO TECHNOLOGIES, INC.

N

0 2,600 5,200 Feet

1 inch equals 5,200 feet

G:\North Carolina\APRINC_PERMIT_8X11.mxd

COASTAL PLANNING & ENGINEERING, INC.

2481 N.W. BOCA RATON BLVD.
BOCA RATON, FL 33431
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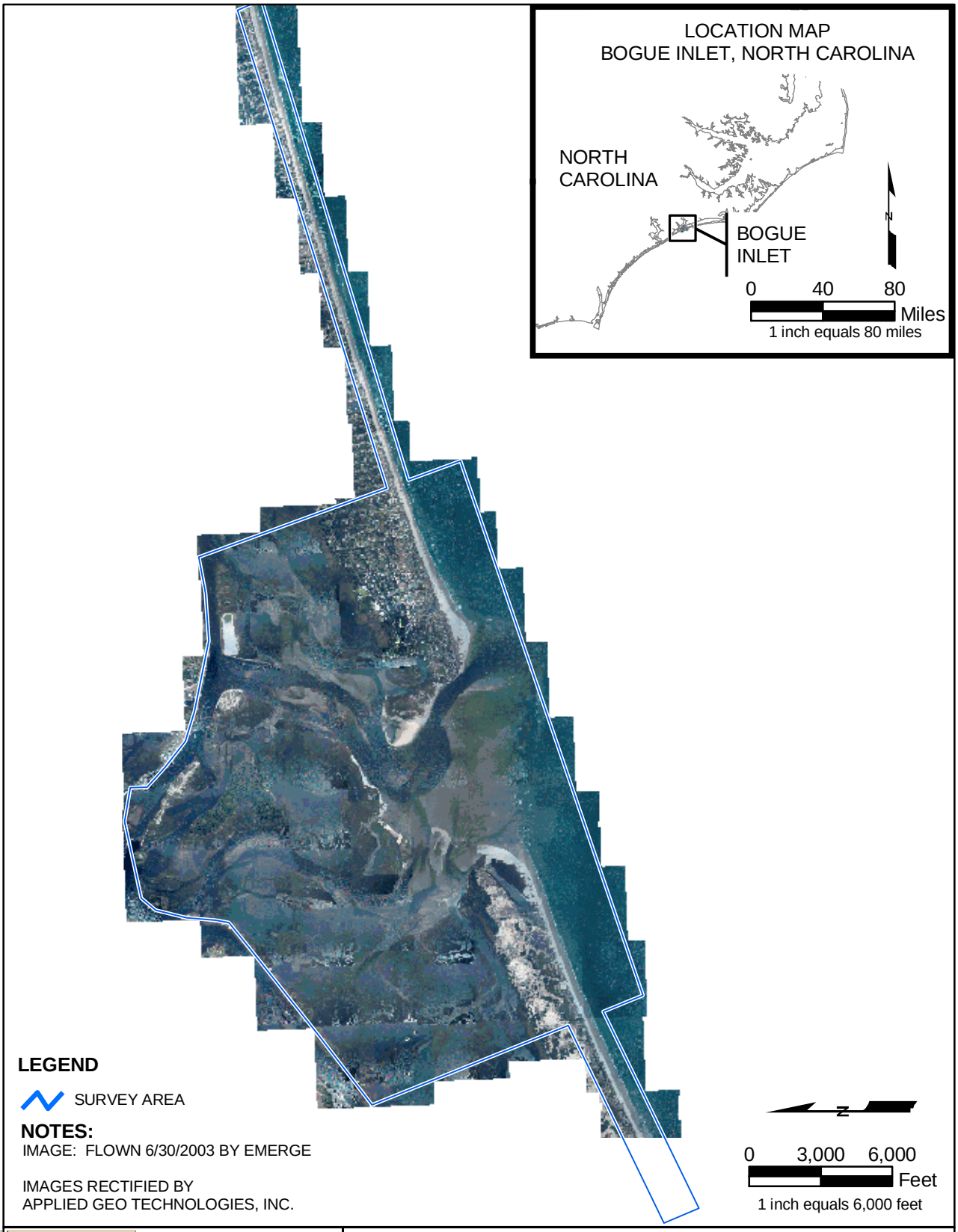
FAX. (561)391-9116

WWW.COASTALPLANNING.NET

TITLE:

BOGUE INLET CHANNEL EROSION RESPONSE PROJECT PERMIT AREA

DATE: 11/05/03	BY: DNR	COMM NO: 5200.02	



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BOCA RATON, FL 33431
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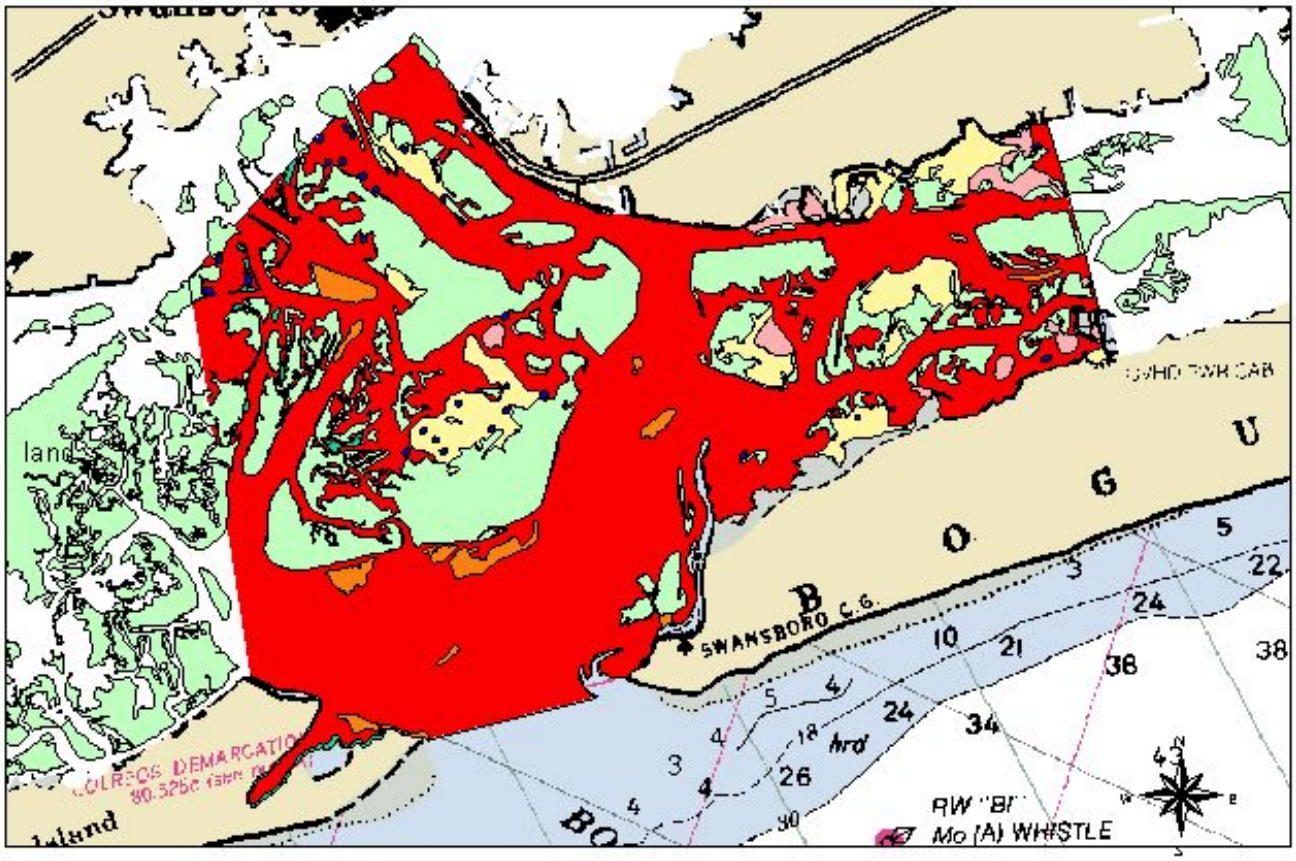
FAX. (561)391-9116

TITLE:

BOGUE INLET CHANNEL EROSION RESPONSE PROJECT SURVEY AREA

DATE: 11/05/03	BY: DNR	COMM NO: 4500.02	

N.C. Division Of Marine Fisheries
Shellfish Mapping Program
C004

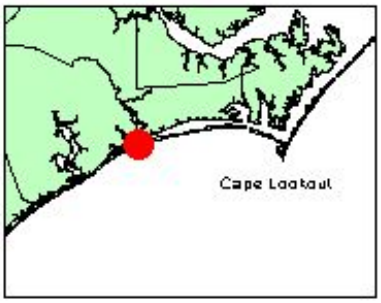


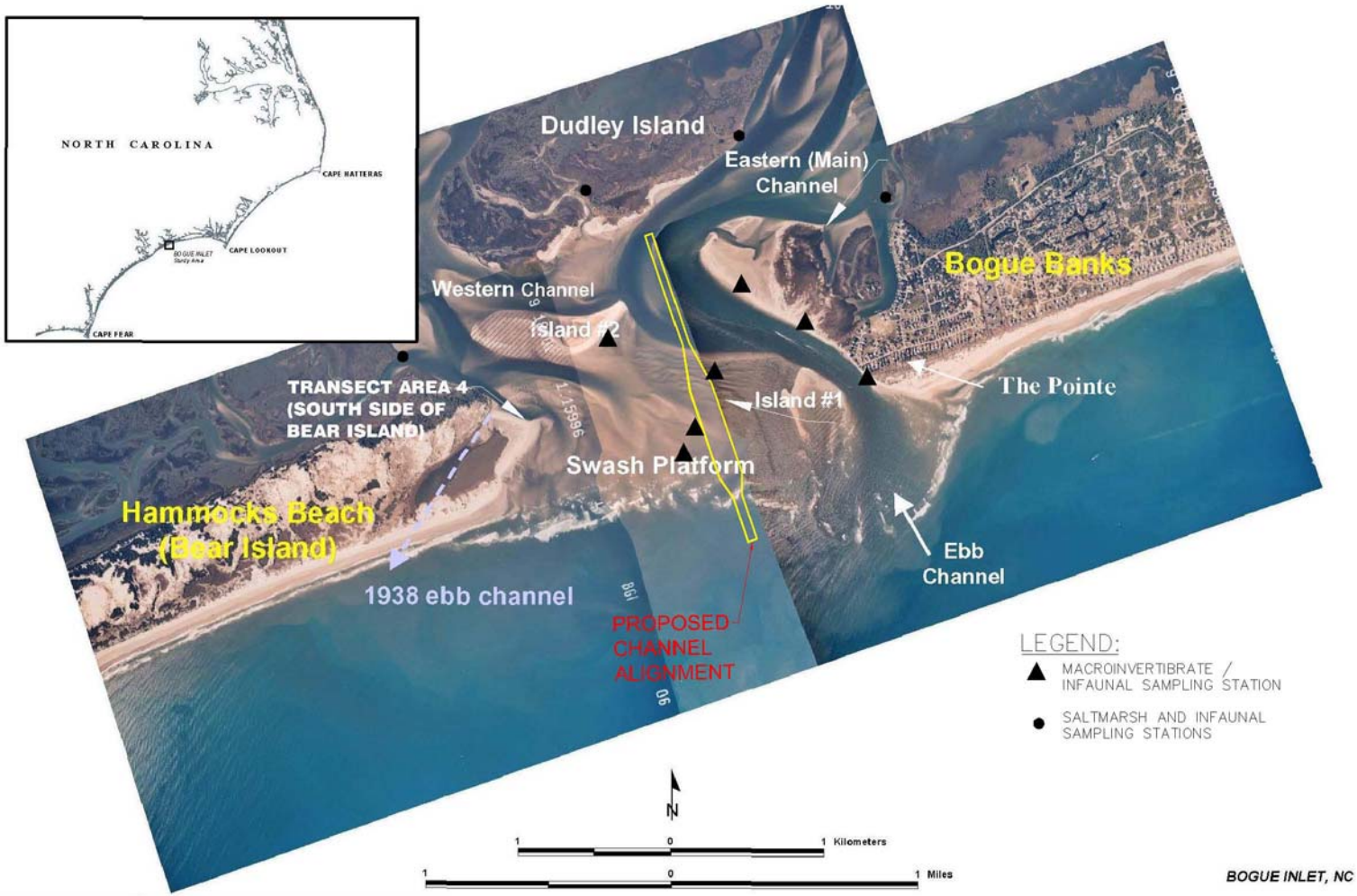
0.5 0 0.5 1 Miles

Strata	Shellfish per square meter
D	0.00
H	0.00
L	0.00
V	24.06
W	76.82
X	0.00

Strata Types

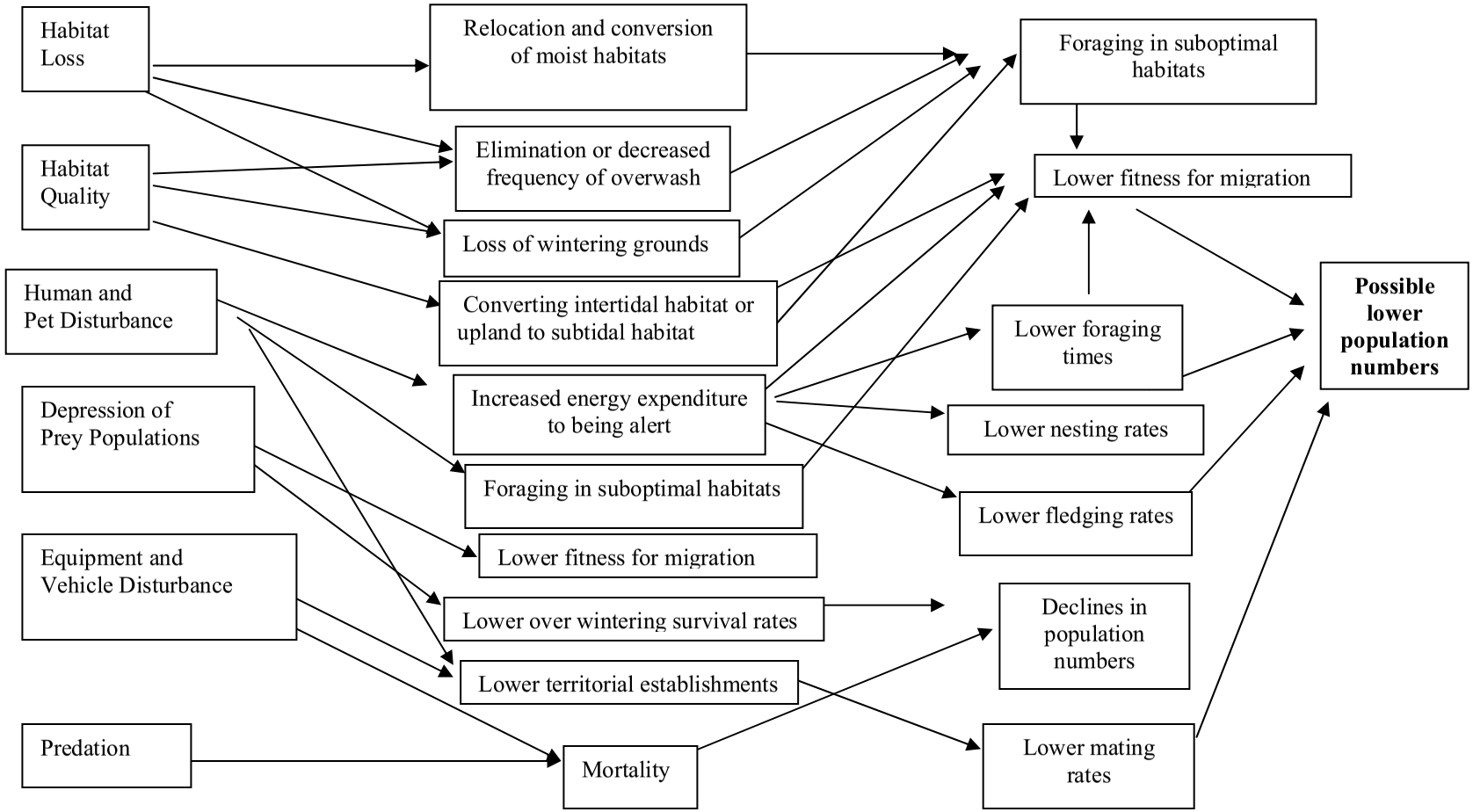
- D - Subtidal Soft Non-vegetated w/o shell
- H - Subtidal Firm Non-vegetated w/o Shell
- L - Subtidal Hard Non-vegetated w/o Shell
- V - Intertidal Hard Vegetated w/o Shell
- W - Intertidal Hard Non-vegetated Shell
- X - Intertidal Hard Non-vegetated w/o Shell
- Land




NORTH CAROLINA
CAPE HATTERAS
CAPE LOOKOUT
BOGUE INLET
Study Area
CAPE FEAR
Dudley Island
Eastern (Main) Channel
Bogue Banks
Western Channel
Island #2
TRANSECT AREA 4 (SOUTH SIDE OF BEAR ISLAND)
Island #1
The Pointe
Swash Platform
Hammocks Beach (Bear Island)
1938 ebb channel
PROPOSED CHANNEL ALIGNMENT
Ebb Channel
LEGEND:
MACROINVERTIBRATE / INFAUNAL SAMPLING STATION
SALTMARSH AND INFAUNAL SAMPLING STATIONS
N
1 0 1 Kilometers
1 0 1 Miles
BOGUE INLET, NC

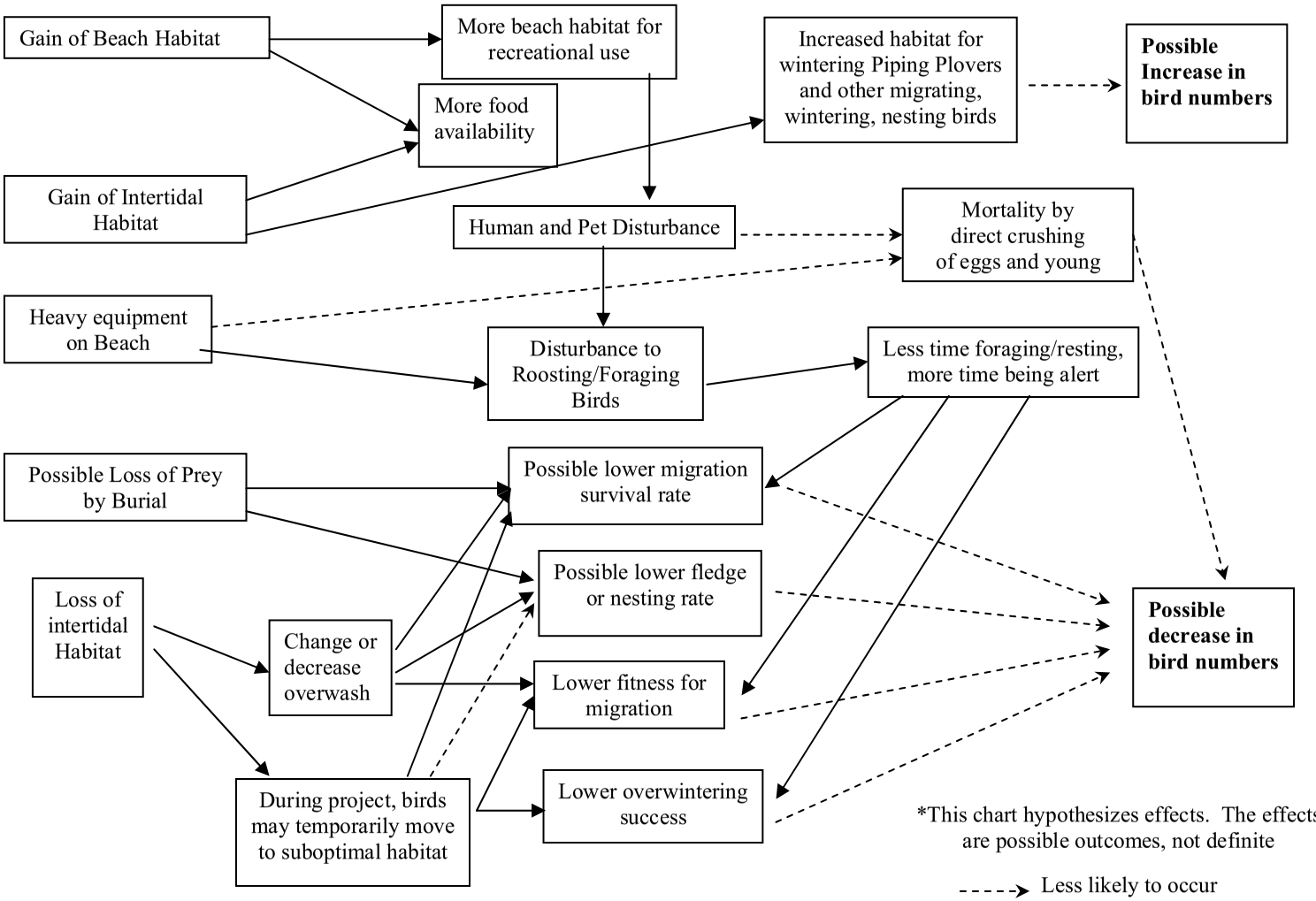
APPENDIX B

CAUSE AND EFFECT RELATIONSHIP FLOW CHARTS

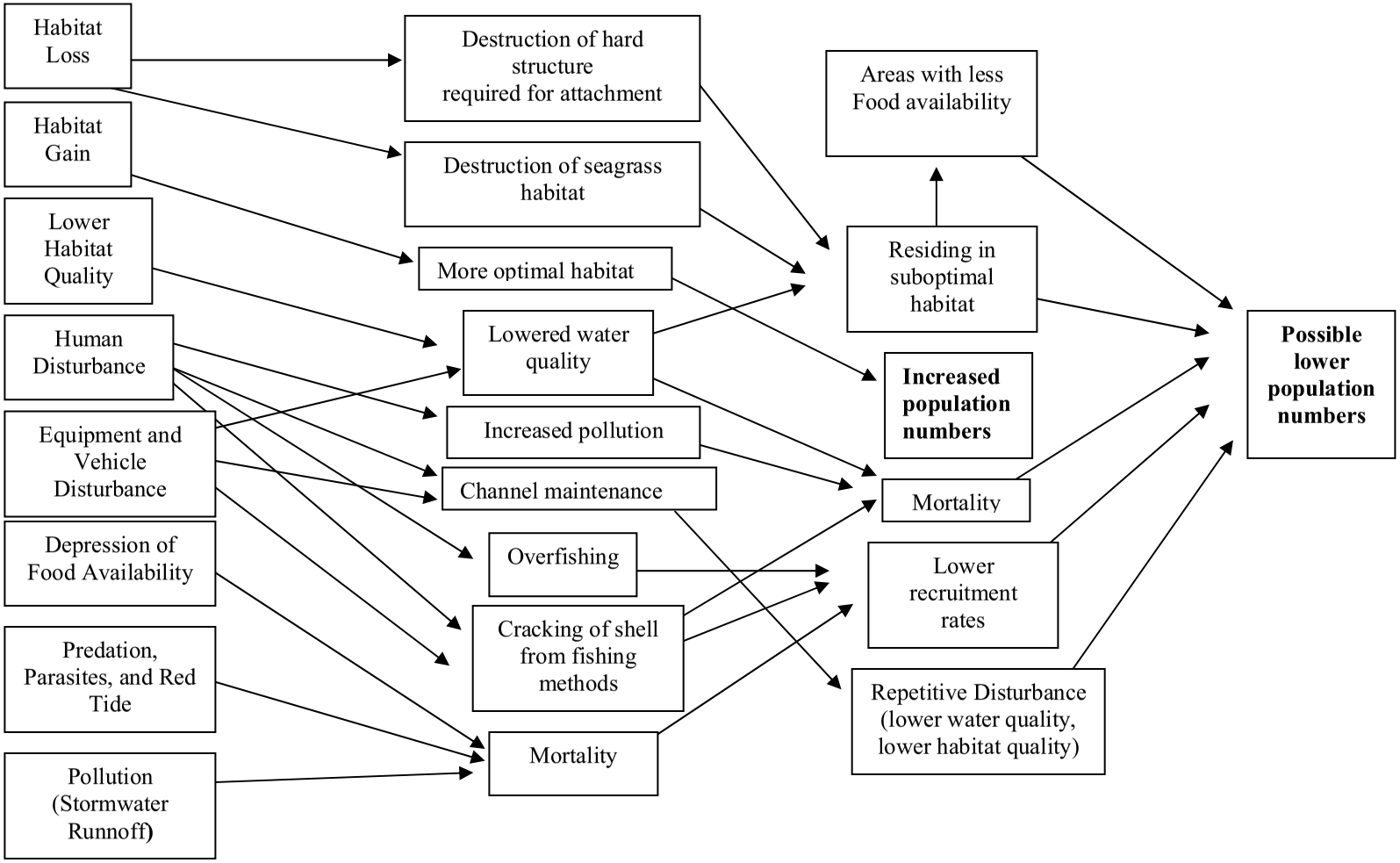


*This chart hypothesizes effects. These effects are not definite

GENERIC ECOLOGICAL CAUSE AND EFECT FOR SHOREBIRDS AND WATERBIRDS

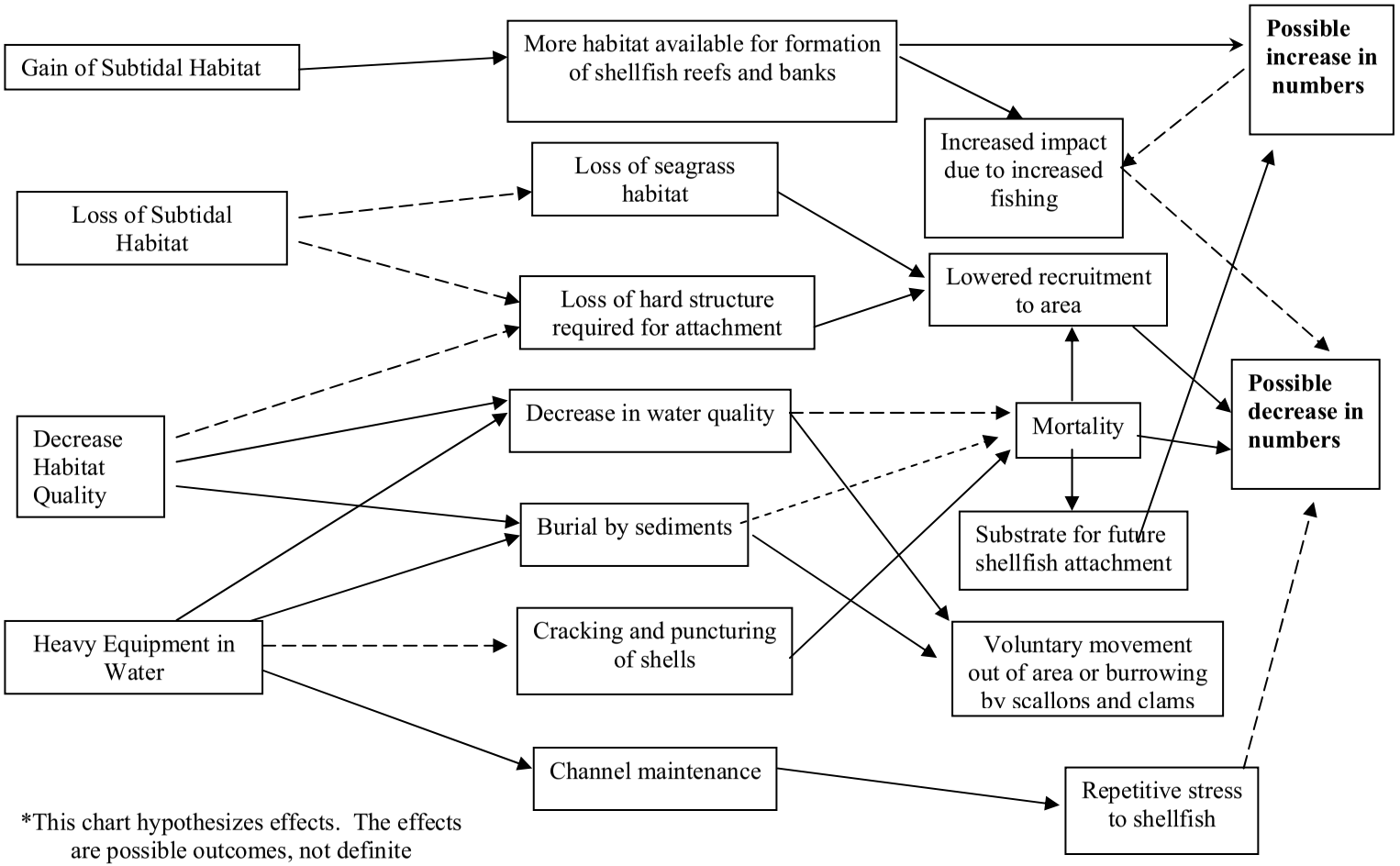


CAUSE AND EFFECT OF BOGUE INLET PROJECT ON SHOREBIRDS AND WATERBIRDS

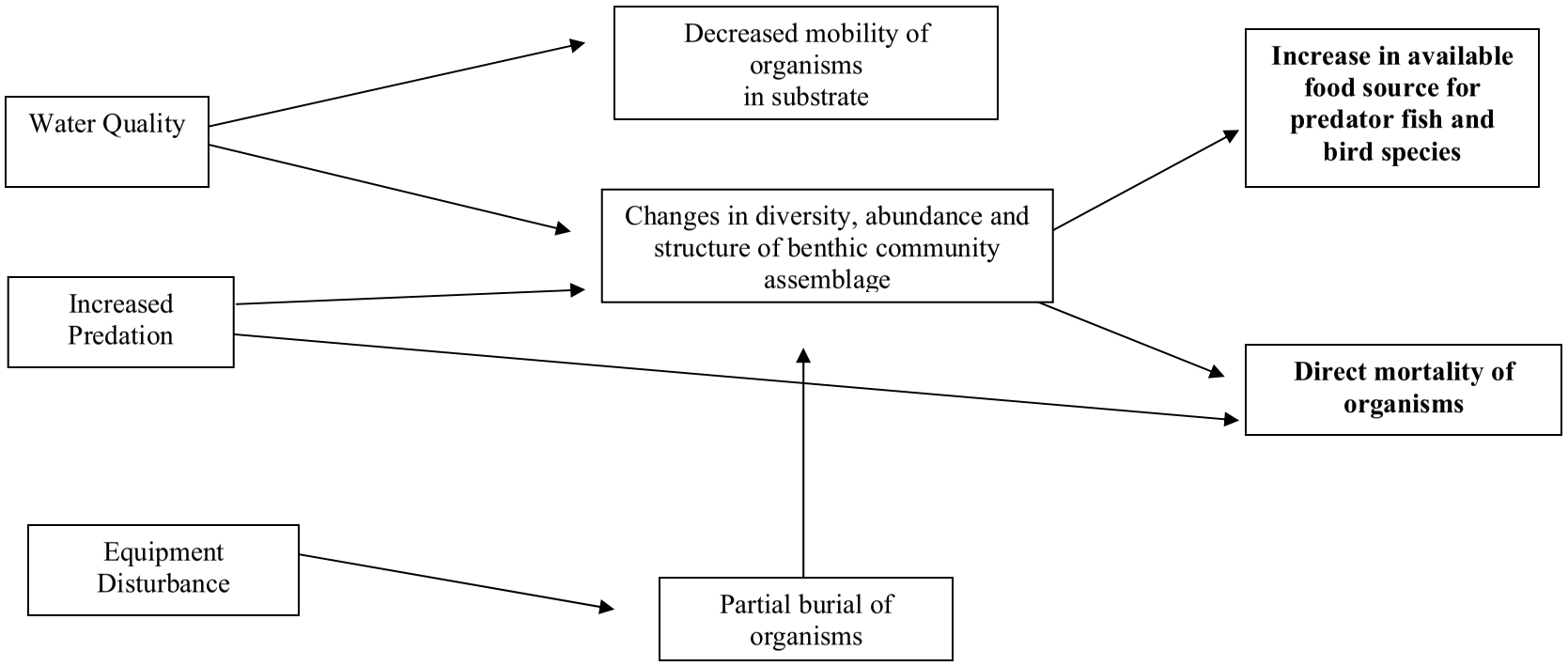


*This chart hypothesizes effects.
These effects are not definite

GENERIC ECOLOGICAL CAUSE AND EFFECT FOR SHELLFISH

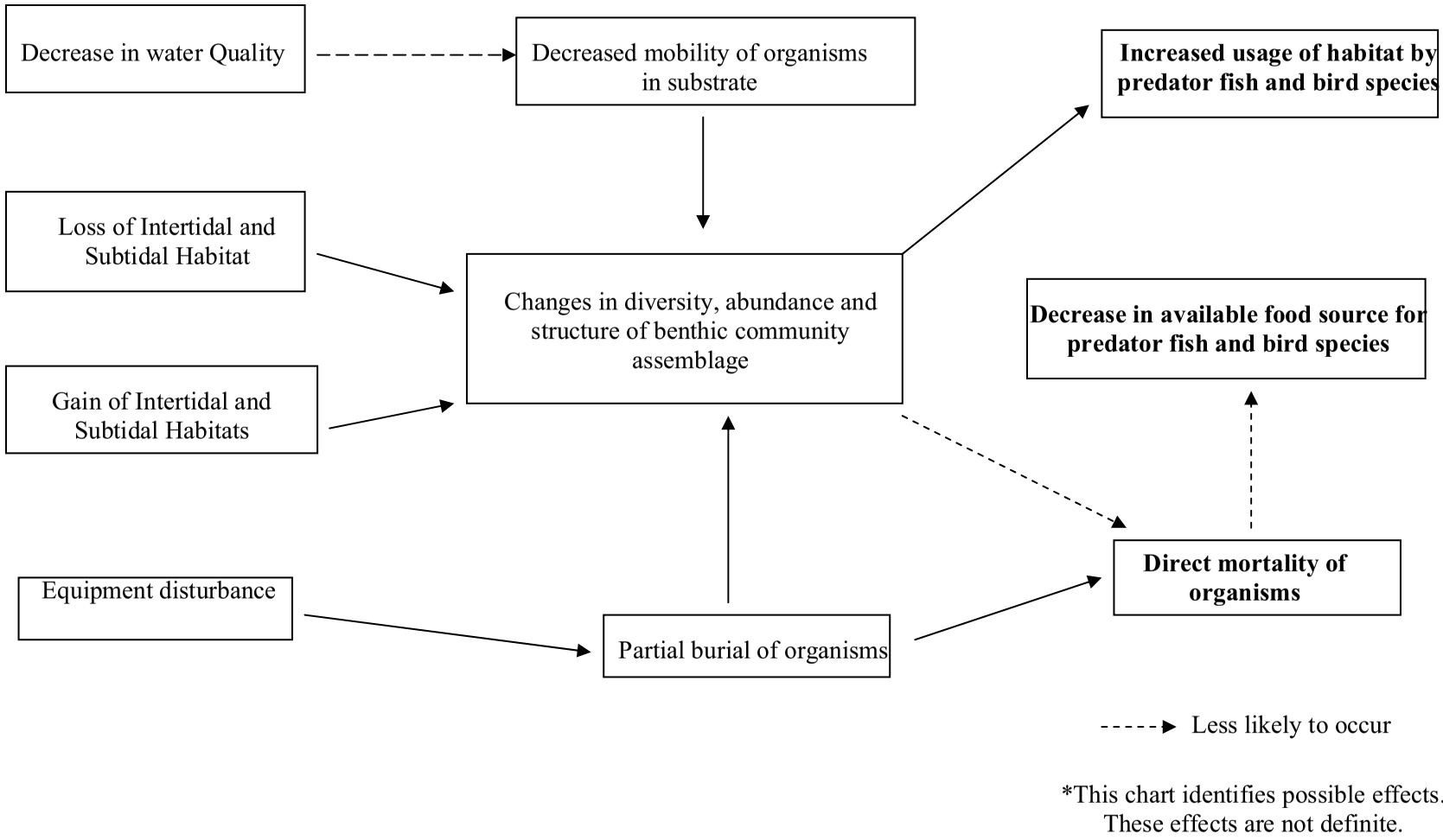


CAUSE AND EFFECT OF BOGUE INLET PROJECT ON SHELLFISH

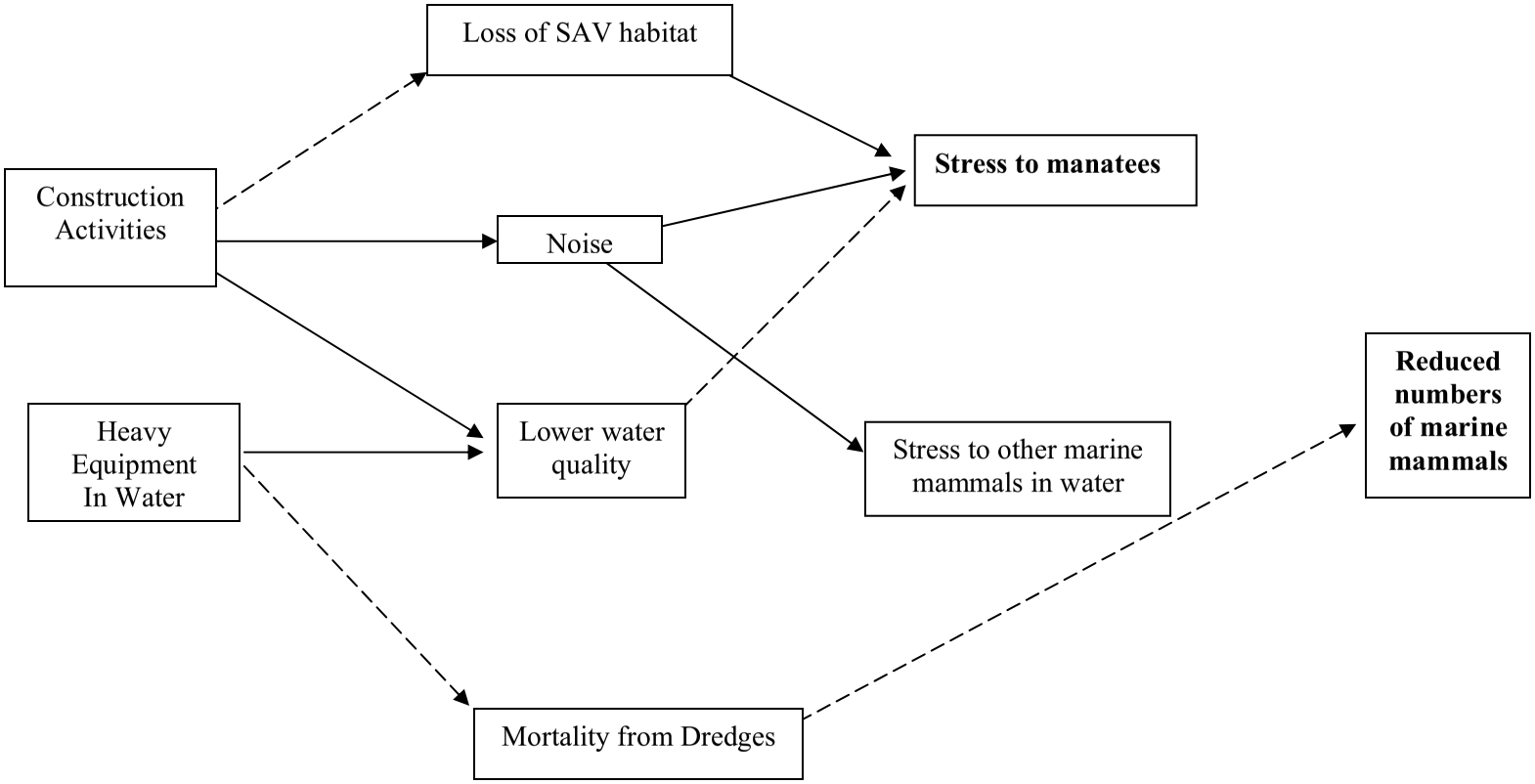


*This chart identifies possible effects.
These effects are not definite.

GENERIC CAUSE AND EFFECT ON THE BENTHIC COMMUNITY



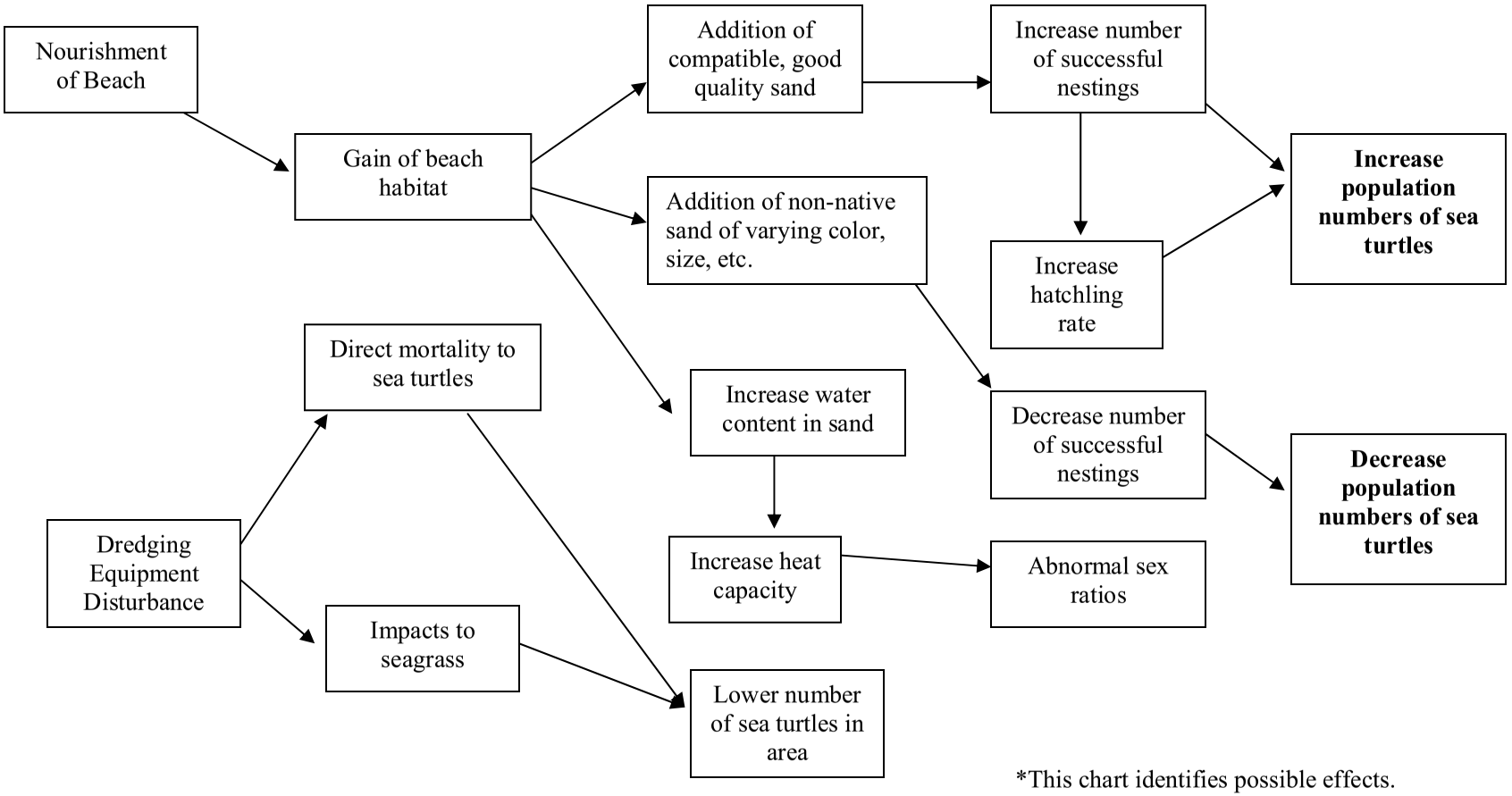
CAUSE AND EFFECT OF BOGUE INLET ON THE BENTHIC COMMUNITY



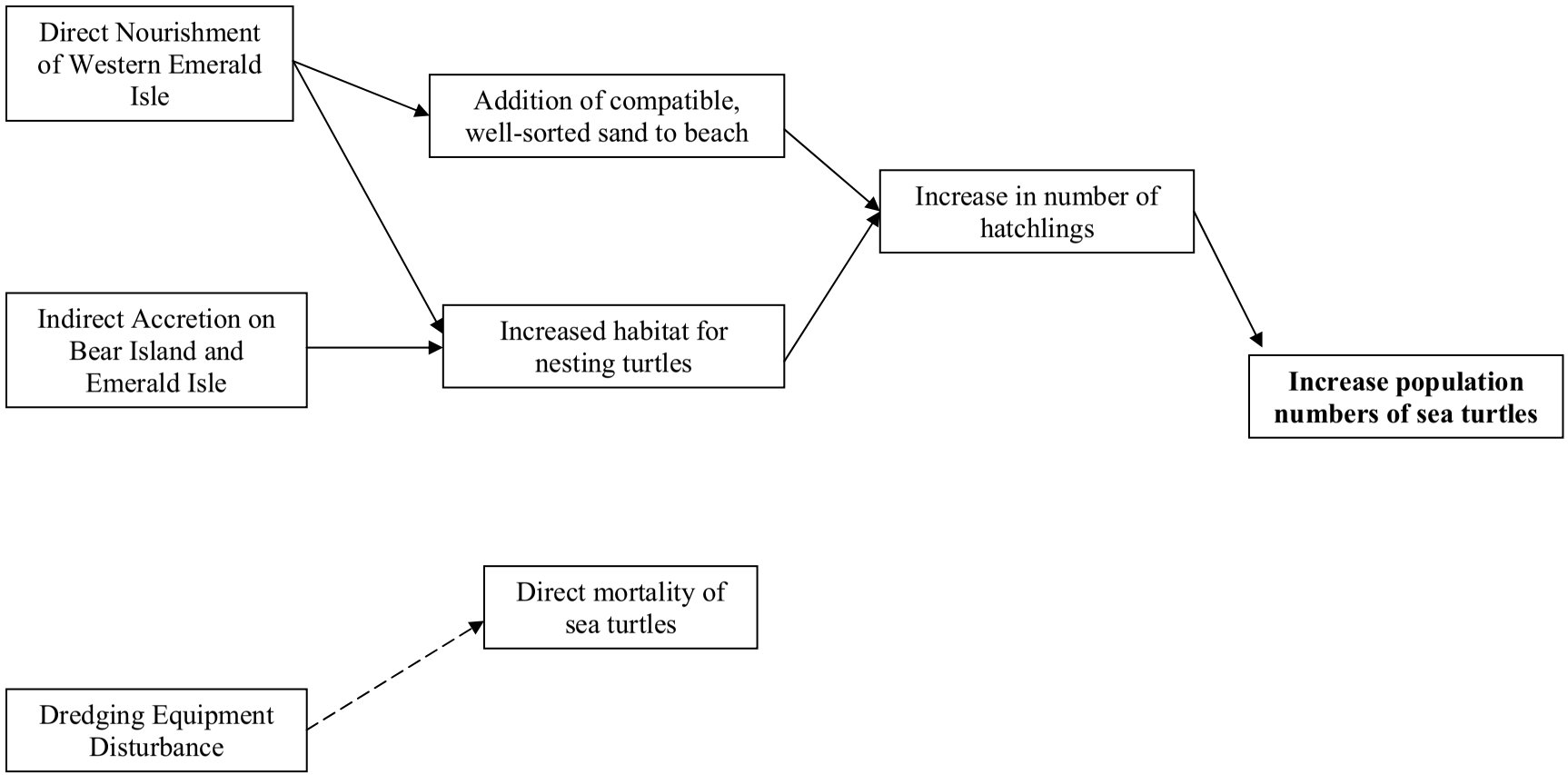
*This chart hypothesized effects. The effects are possible outcomes, not definite.

– – – – – → Less likely to occur

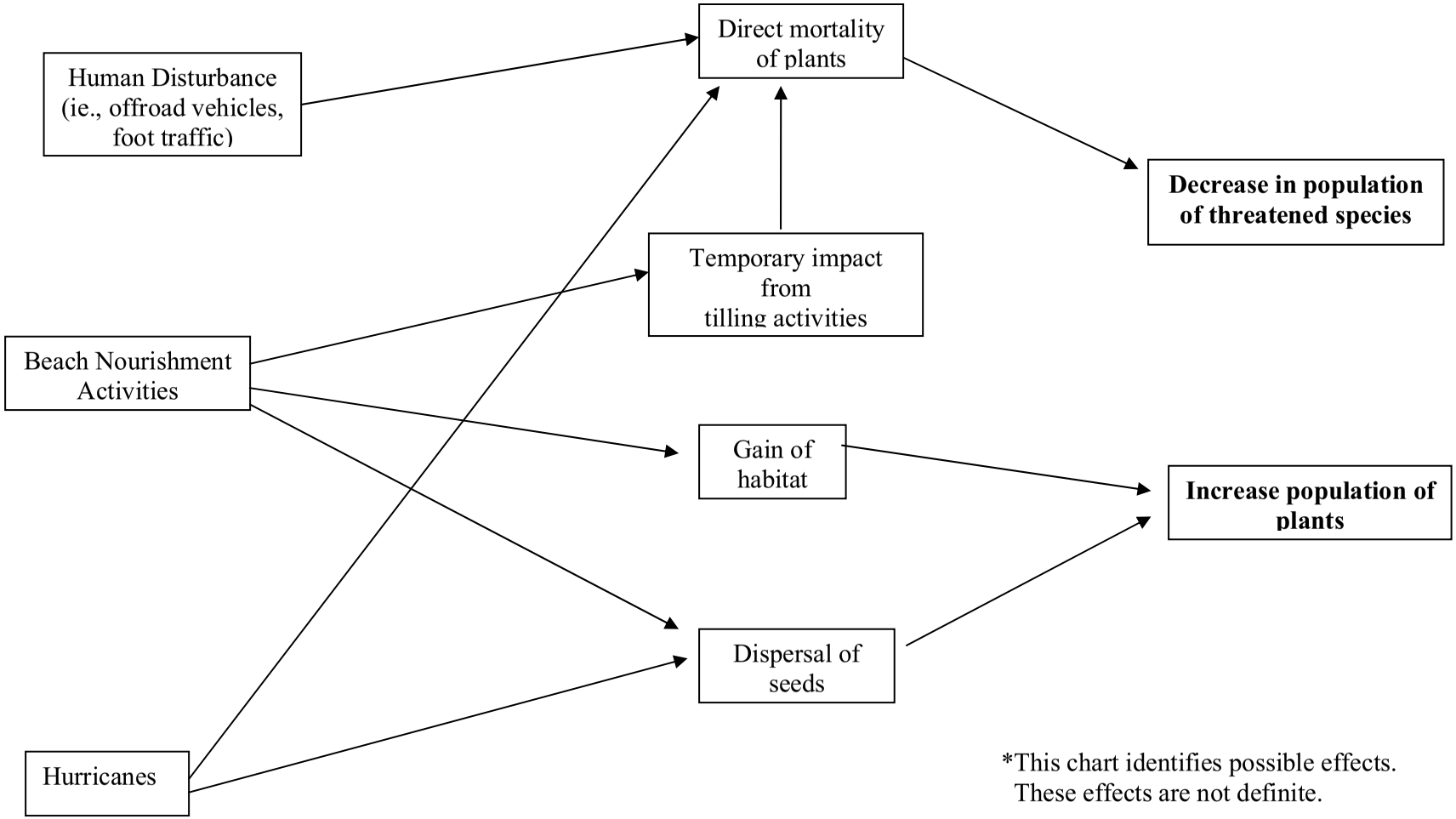
GENERIC ECOLOGICAL CAUSE AND EFFECT FOR MARINE MAMMALS



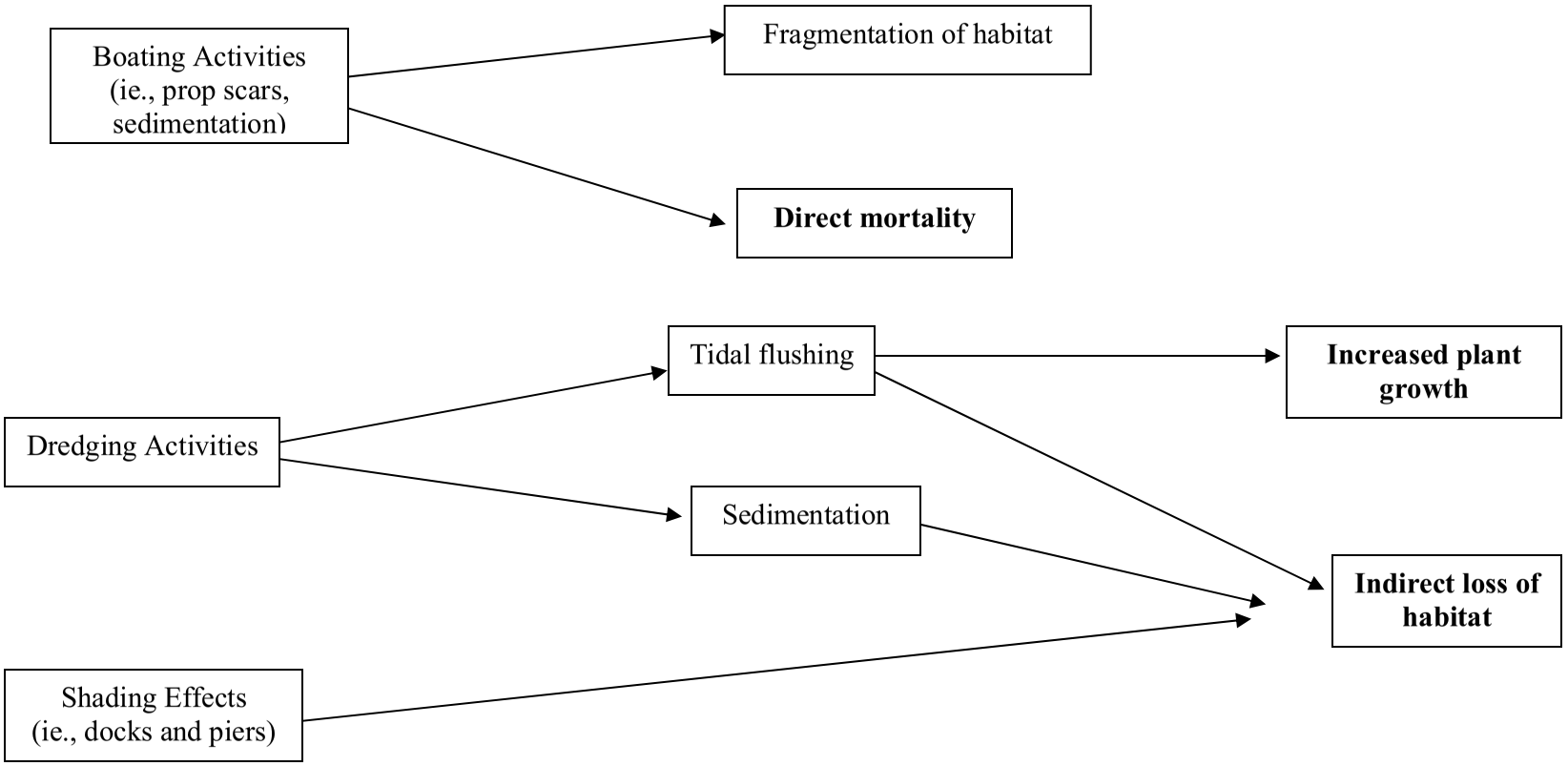
GENERIC ECOLOGICAL CAUSE AND EFFECT FOR SEA TURTLES



CAUSE AND EFFECT OF BOGUE INLET PROJECT ON SEA TURTLES

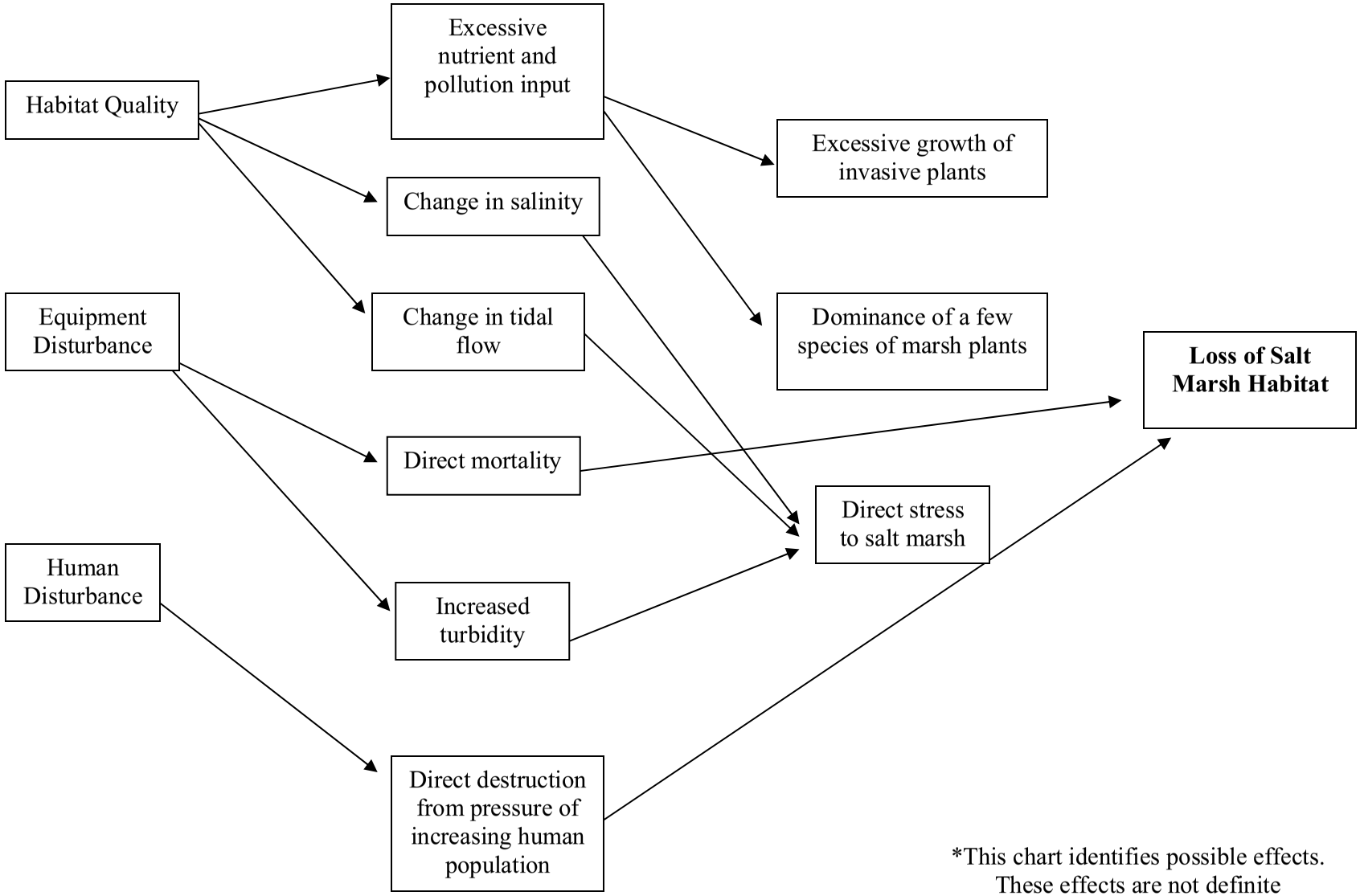


Generic Cause and Effect on Seabeach Amaranth

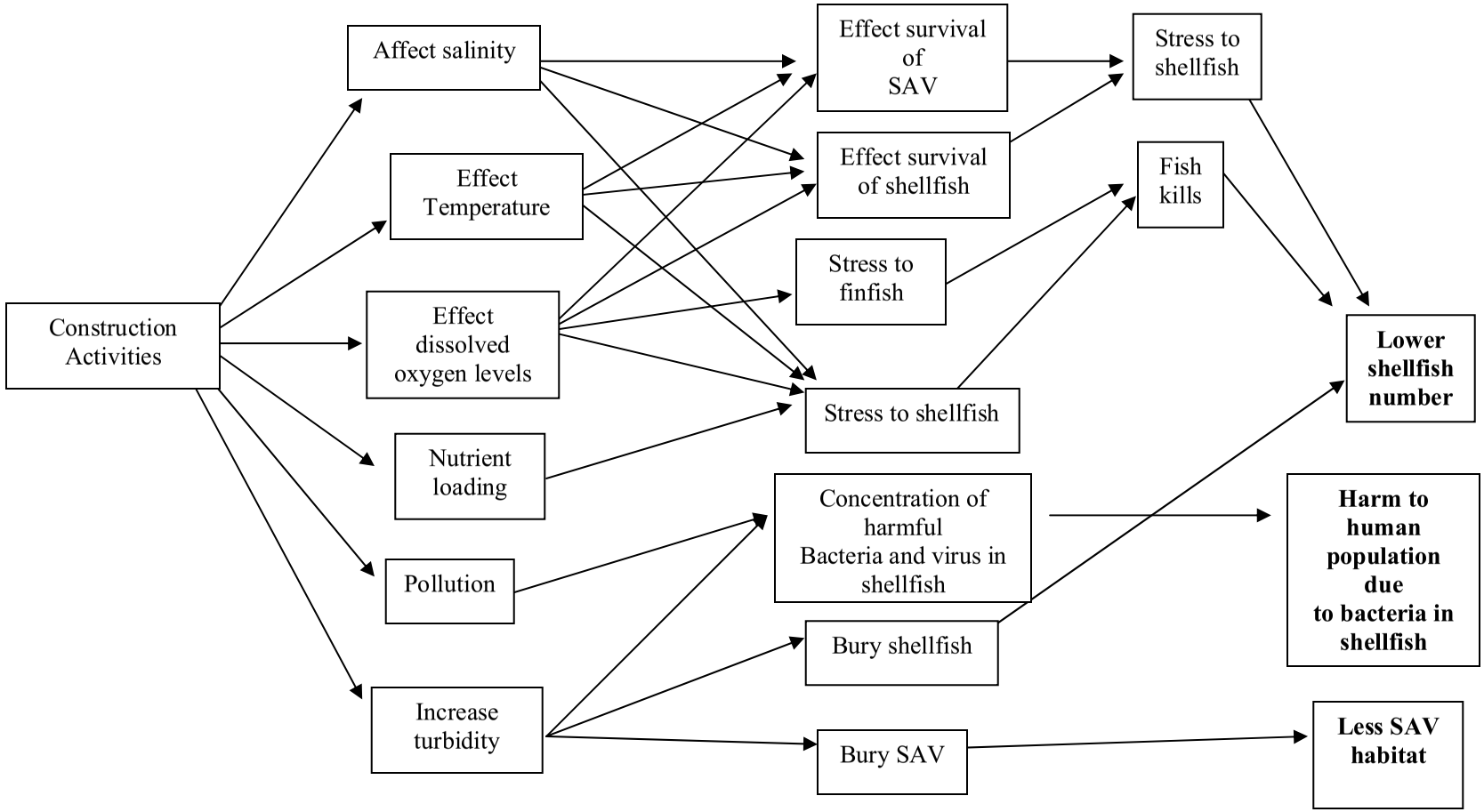


*This chart identifies possible effects.
These effects are not definite.

GENERIC CAUSE AND EFFECT FOR SUBMERGED AQUATIC VEGETATION

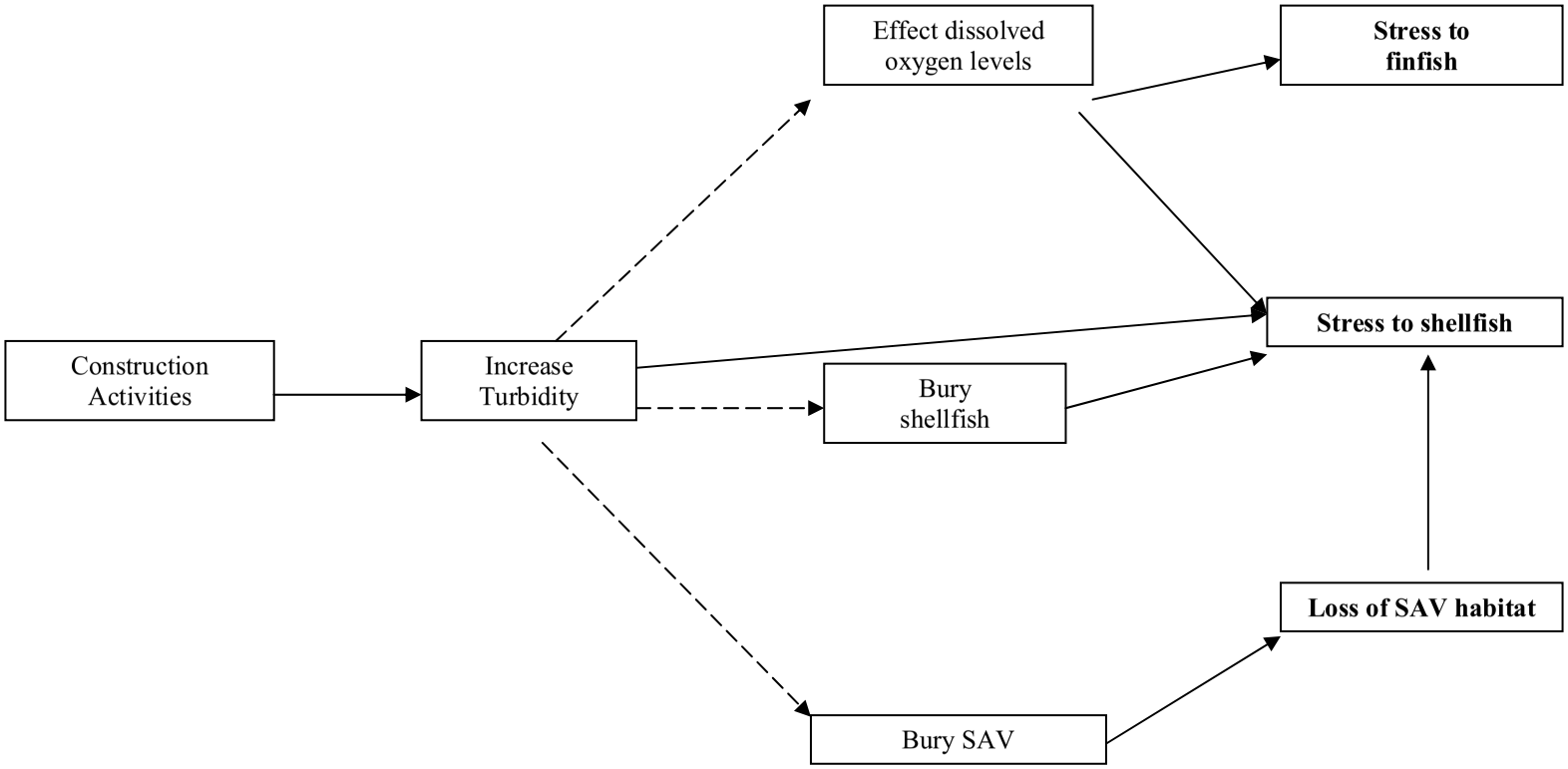


GENERIC ECOLOGICAL CAUSE AND EFFECT FOR SALT MARSH ECOSYSTEM



*This chart hypothesizes effects. These effects are not definite

GENERIC ECOLOGICAL CAUSE AND EFFECT ON WATER QUALITY



*This chart hypothesized effects. The effects are possible outcomes, not definite.

– – – – ▶ Less likely to occur

CAUSE AND EFFECT OF BOGUE INLET RELOCATION PROJECT ON WATER QUALITY